**Department of Energy**
Albuquerque Operations Office
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April 16, 1997

Mr. Joseph J. Holonich, Chief
Uranium Recovery Branch
Office of Nuclear Materials
Safety and Safeguards
Mail Stop T7J9
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20852-2738

Dear Mr. Holonich:

Enclosed are the Department of Energy's responses to comments made by the Nuclear Regulatory Commission in their transmittal dated February 4, 1997, on the draft Completion Report, dated June 1995, for the remedial action of the Mexican Hat and Monument Valley processing sites. In support of these responses, also enclosed are page changes (numbered Attachment 1 through 4) for incorporation into your copies of the Completion Report.

Each Attachment contains redlined pages to show where text was added and deleted. Behind the redlined pages are the replacement pages for incorporation into the Completion Report. Please follow this step-by-step procedure for revising your copies of the Completion Report.

1. Volume 1. Turn to the tab entitled "Remedial Action Assessment" in Volume 1. Remove and destroy pages 10 through 16. Insert replacement pages contained in Attachment 1.

2. Volume 5. Turn to page 1 of Appendix J in Volume 5. Remove and destroy pages 1 through 12 of the written text only. Insert replacement pages contained in Attachment 2.

3. Volume 5. Remove the letter addressed to Jim Oldham from Mark Mathews dated December 1, 1989. This letter is located six pages after the aerial photographs. The aerial photographs are located in Volume 5 immediately after the data tables.

4. Volume 5. Insert the replacement pages contained in Attachment 3 in front of the letter to Jim Oldham from Mark Mathews dated May 10, 1989. This letter is located nineteen pages after the aerial photographs. The aerial photographs are located in Volume 5 immediately following the data tables.

5. Remove all draft covers and spines and replace with the final covers and spines.

Please give me a call at (505) 845-5668 if you have any questions.

Sincerely,

Sharon J. Arp
Site Manager
Uranium Mill Tailings Remedial Action Team
Environmental Restoration Division

2 Enclosures

cc w/o enclosures:
H. Lefevre, NRC
J. McBee, TAC

RESPONSE TO COMMENTS
MEXICAN HAT/MONUMENT VALLEY DRAFT COMPLETION REPORT

Volume 1, Remedial Action Assessment Section

1. Discussion: The Remedial Action Assessment Section, which discusses Pre- and Post-Remedial Action Site Conditions, should include appropriate information on the buildings on the Mexican Hat site. This revision is needed because, according to Remedial Action Plan (RAP) drawing 10-J211, the former clinic and shop building are on the designated site.

   Comment: Revise the Remedial Action Assessment Section to include appropriate information on the former clinic and shop building.

   Response: The DOE agrees with the comment.

   Implementation: The Remedial Action Assessment Section and Appendix J, Section 6, have been revised to include information on the former clinic and shop building.

2. Discussion: Page 12 indicates that the Opposed Crystal System (OCS) measured the 1765 kev peak for Bi-214, but page 13 states that the RTRAK used the 609 kev peak for Bi-214.

   Comment: Discuss the two systems and the differences in the values.

   Response: The 1765 keV photo peak was chosen for OCS analysis because this region of the gamma spectrum does not have any other gamma peaks (in tailings and ore materials) that cause direct interference. Due to the low activities associated with near background samples and the relatively small sample size (500 g), a peak with minimal interference was required to estimate the concentration of Ra-226. The OCS system has been optimized to analyze for Ra-226 while minimizing interference from other naturally occurring radioactive materials such as Th-232.

   On the other hand, the RTRAK uses four large area detectors and each detector measures gamma radiation in the 609 keV region of the gamma spectrum to estimate concentrations of Ra-226 in soil. The 609 keV photo peak of Bi-214 was chosen because it has a higher emission rate than the 1765 keV photo peak. This higher emission rate provides better counting statistics and, in turn, faster analysis. Faster analysis is advantageous for the RTRAK mobile gamma system because it moves during analysis. The 609 keV gamma region has an interfering photopeak from Tl-208 (583 keV), a decay product of Th-232. Using the 609 keV gamma region provides a conservative estimate of Ra-226 and also provides the added advantage of identifying areas of elevated Th-232, if encountered.

   Implementation: None.

Volume 5, Appendix J

3. Discussion: On Page 5 of Appendix J, DOE indicates that although some laboratory results exceeded the standards, the samples sent to the independent laboratory were for quality assurance purposes. DOE further states that individual sample results are not to be compared to the field measurements for the same sample. Although the NRC staff acknowledges that the difference between the paired results do not appear significant, the staff does not agree with the DOE's rationale for not comparing the independent laboratory results with field measurements. While a certain amount of variation in results is expected for splits of samples analyzed by different laboratories, an effort should be made to find the reason for the difference when there are recurring significant differences.

Comment: DOE needs to provide additional justification for this position.

Response: The purpose of the independent laboratory analysis is not to provide a quality control check on each sample analyzed, but to provide quality assurance for the overall site verification program. The independent laboratory analysis provides a system to identify overall bias that may be present by comparing two different analysis systems. Because the average radium-226 concentration is the same for both the OCS and Barringer, this provides an indicator that there is very little overall bias. On a daily basis, quality assurance is maintained by analyzing NIST traceable soil standards.

Implementation: None.

4. Discussion: On page 6, DOE indicates that the sewage ponds were not sampled, because of the biological hazards, even though remediation and verification occurred along one side. Tailings could have extended under the east end of the ponds.

Comment: Since tailings could have extended under the east end of the ponds, address what data were collected or observations were made along this bank of the excavation during remediation. If material was left, indicate the ownership of the ponds and the expected long-term use of this area.

Response: Soil verification samples were not collected in the pond due to the presence of the biological hazards. However, contaminated material was removed during remediation up to the pond dike. Soil samples collected from the exposed face of the dike indicated that the site was cleaned to the EPA standards. Since the EPA standards were met at the exposed face of the dike it is not believed that contaminated material extended under the pond.

Implementation: This additional information has been added to Appendix J of the Completion Report.

5. Discussion: On page 7, DOE indicates that a 10 pCi/g cleanup limit was used for the Th-232, although the RAP stated that the limit would be 5 pCi/g. In a DOE letter dated December 1, 1989, DOE indicates that this decision was based on NRC's limit of 10 pCi/g in guidance titled "Disposal of Onsite Storage of Thorium and Uranium Wastes from Past Operations" (46 FR 52061).

DOE should note that the NRC guidance indicates that 10 pCi/g is the level for the Th-232 plus Th-228. If the analysis only measures Th-232 then, assuming equilibrium with Th-228, the Th-232 limit is 5 pCi/g, at least for surface soil. This is supported by a 1986 letter from EPA (see attachment). DOE should not have increased a cleanup limit that was approved with the RAP, without NRC approval of the new limit through review of a RAP modification. Also, DOE should have ensured that NRC guidelines were interpreted correctly, and should have considered that the Th-232 guideline would need to be modified (decreased) if residual tailings were found in the same verification grid.

Comment: DOE should revise the Completion Report to clarify the misunderstanding on the Th-232 cleanup limit and should justify the use of 10 pCi/g with a health risk assessment.

Response: The text on page 7 is misleading. The DOE and RAC understand that the 10 pCi/g limit includes both Th-232 and Th-228. The 5 pCi/g limit for Th-232 cleanup at the Mexican Hat site was used according to the requirements given in the RAP. Compliance with the EPA standards is demonstrated using site laboratory (OCS) results and all of the results were below or equal to 5 pCi/g. Therefore, there is no need to conduct a health risk assessment.

Implementation: To avoid confusion, the statement on page 7 regarding the DOE letter of direction has been deleted. Please remove the referenced letter from the completion report.

6. Discussion: On page 10, DOE states that "...Since the HGVS quality control verification samples were taken according to criteria established in verification procedures, the results from site OCS measurements are reported in the OCS soil verification tables and in the HGVS verification table lab results." It is important to note that OCS values are not the same as lab values.

   Comment: Because OCS values are not the same as lab values, DOE should correct the column heading in the HGVS verification table.

   Response: The statement referenced in the above discussion is misleading and therefore, will be deleted from the completion report. Some of the quality control samples for the HGVS verified grids were analyzed by Barringer and others were analyzed by the onsite (OCS) laboratory. It was not felt to be necessary to distinguish which laboratory the QC sample was analyzed by since both laboratories are considered to be acceptable for verifying site cleanup. For those QC samples that were analyzed by the onsite OCS laboratory their results can also be found in the OCS soil verification tables.

   Implementation: Page 9 has been revised to indicate that QC samples were analyzed by either Barringer or the onsite OCS laboratory. In addition, the above referenced statement has been deleted from page 10.

7. Discussion: On page 11, DOE indicates that some areas of the sheet metal shop (warehouse) were decontaminated. On page 12, DOE indicates that the fixed surface activity for Area E2 meets the limit when averaged (2,065 dpm) over one square meter, as allowed under NRC guidance (Regulatory Guide 1.86).

   Comment: Provide adequate data to support the conclusion that the warehouse meets the NRC (or DOE) released guidance of 5,000 dpm/100 $cm^2$ total (not fixed) contamination averaged over one square meter and 15,000 dpm maximum total contamination for any 100 $cm^2$.

   Response: The removable data is provided, along with the fixed data on the data sheets included at the back of Appendix J. This data indicates that total contamination limits have been met.

   Implementation: The text in Appendix J, Section 6 has been modified to indicate compliance with the total contamination limits.

8. Discussion: On page 11, DOE indicates that the contact gamma reading on the surface of the warehouse (former sheet metal shop) was 50 uR/hr, so brick and cinder block samples were sent to a laboratory for analysis.

   Comment: The laboratory data from the brick and block analysis and DOE's assessment of the results need to be provided as an addendum to the CR, so that NRC can complete its review.

   Response: The DOE concurs that the analysis information and an assessment of the information should have been included in the completion report.

   Implementation: The information has been added to Appendix J.

9. Discussion: Verification data is presented for grid blocks C-2, 3, 4, 10, 11, 17, 18 and 19; and blocks CC-37 to 47. However, the area represented by these grid blocks is not indicated within the contamination excavation area on drawing HAT-SV-000.

   Comment: Indicate why verification data is presented for the above grid blocks but is not indicated within the contamination excavation area shown on drawing HAT-SV-000.

   Response: There were some areas of contamination that fell outside the indicated boundary that were associated with the drainage to the northeast of the pile. These areas were excavated and verified according to EPA Standards.

   Implementation: Appendix J text has been modified to discuss these areas.

10. Discussion: Although contamination was found in the west half of block EE, and in blocks E-25, 26, 33, 42, and 43, these areas do not appear to be continuous with the windblown contamination.

    Comment: Indicate what type of contamination was found in the indicated areas.

    Response: The areas outlined in Area EE had contamination that was associated with the drainage. The contamination was waterborne rather than windblown.

    Implementation: Appendix J text has been modified to discuss these areas.

11. Discussion: Grid J-15-02 has Th-230 at 24 pCi/g so that the 1000-yr Ra-226 level is 12.1 pCi/g, but it is the only grid on the page that indicates excavation was deeper than 15 cm. A similar situation exists (isolated grid had deeper excavation and higher radionuclide level) for many grids that exceed the surface cleanup guideline.

    Comment: Indicate how depths of excavation (or areas that were not backfilled) were tracked and how this information was provided for the grid data tables. Alternatively, indicate why these isolated "hot spots" were prevalent on this site.

    Response: Depths of excavation were not tracked because it is irrelevant in determining compliance with EPA standards. However, areas that were backfilled with greater than 15 cm of backfill were determined and tracked using the construction drawings and field observations. Other areas were considered to have received less than 15 cm of backfill. The statement that isolated "hot spots" were prevalent on this site is misleading and inaccurate. All areas were remediated to comply with required EPA standards. However, there were a few small areas where small pockets of material were deposited which resulted in deeper excavations than the surrounding area. This is especially prevalent in the waterborne contamination locations due to the irregularity of the original ground surface and the location of underlying rock features.

    Implementation: None.

12. Discussion: There are no laboratory quality control (QC) data for the first three pages of HGVS measurements for block K.

    Comment: Assuming the absence of such data, indicate how QC samples were chosen for the HGVS measurements.

Response: HGVS QC sample locations were selected at random. Selection in this manner produces irregular aerial coverage, thus the reason for no QC data for the first three pages of block K.

Implementation. None.

Volume 5, Appendix J, Monument Valley Verification Grid Data

13. Discussion: Monument Valley grid N-3-16 is reported to have 10 pCi/g Th-230 in the top 6 inches of soil. It was NRC staff's understanding that Th-230 would be removed to near background (1-2 pCi/g) levels for surface soil (ALARA).

Comment: Explain the Th-230 limit for surface soils that was used and the potential health risk from inhalation of this residual Th-230.

Response: The final RAP, dated February 1993, stated that for most of the excavated area residual contamination should not exceed 5 pCi/g for Th-230. Following the approval of the final RAP, the "Generic Protocol for Th-230 Cleanup/Verification for UMTRA Project Sites" was approved by NRC. This protocol allows use of 1,000 year Ra-226 standards based on decay and ingrowth of Ra-226 and Th-230. All final verification data having both Ra-226 and Th-230 analysis results were compared to the 1,000 year Ra-226 standards. For the top 15 cm of soil they were compared to 5 pCi/g (plus background) and for layers at depths greater than 15 cm they were compared to 15 pCi/g (plus background). A health risk assessment was conducted using the RESRAD computer program for a hypothetical person continuously exposed for one year to 10 pCi/g of Th-230 in the top six inches of soil for 30 years. The estimated dose to the hypothetical person would be approximately 5 mrem/year. This is considered to be negligible if compared to the 100 mrem public dose guideline given in NRC and DOE guidance.

Implementation: None

Volume 6B, Appendix B, Calculation 9-421-05-00

14. Discussion: Table B1 appears to be missing data for the top 1.5 or 2.5 foot sample interval. It is not clear if the top sample includes the radon barrier, as well.

Comment: Indicate if the radon barrier was in place when the samples were taken and why there is an apparent inconsistency in the thickness of the top sample.

Response: There is no data missing from Table B1. The samples were taken as the contaminated materials were being placed, prior to placement of the radon barrier. These samples were obtained over a five year period, with the initial samples taken in April 1989 and the final samples in March 1994. More specific information about the samples is included in Appendix A, sheets A-2 through A-7, of the calculation.

The data on the elevation of the top of riprap (top elevation) was based on top elevations of the completed cell in March 1994. These elevations were confirmed by an aerial survey completed in April 1995. It is not surprising that there are minor differences in elevations between the top samples of the contaminated material and the bottom of the radon barrier. The elevations of the top samples of contaminated material were taken at different times and to differing degrees of accuracy. The elevation at the bottom of the radon barrier was based on a relatively accurate final survey.

Implementation: None.

15. Discussion: For most of the 20 locations the value for one sample is used for 2 or 3 different layers in the radon flux model.

Comment: Indicate why, for most of the 20 locations, the value for one sample is used for different layers in the radon flux model.

Response: Because the author of the NRC comment was not specific regarding where in the calculation values for one sample are repeated for 2-3 different layers, only general information is provided on how the flux modeling was performed. The input parameters for each of the 20 sample locations are summarized in Table C. The Ra-226 levels and emanation fractions are taken from Table B-1. As explained above, in some cases the final top slope survey elevations resulted in the bottom of the radon barrier being higher than the top of the contaminated. In this case the gap between the two materials was modeled by assuming it had the same parameters as the underlying sample. When the bottom of the radon barrier was lower than the top of the sampling layer, the thickness of the layer used in the modeling was reduced.

Three different values for diffusion coefficient and long-term moisture were used, based on the source of the contaminated materials (see Sheet A-9). Dry densities were based on the origin of the materials and its location in the pile (see A-9). Depending on the origin of the contaminated materials, several layers could have the same properties.

Implementation: None.

16. Discussion: The emanation fractions for the first samples at locations R4 and R20 are very low (0.02 and 0.01).

Comment: Provide further explanation of the low values of the emanation fractions and indicate why such values are acceptable.

Response: The emanation fractions are from actual laboratory test results (see Appendix A). The uppermost materials of the disposal cell were windblown/waterborne contaminated materials. When excavating these materials, it was impossible to separate them from adjacent uncontaminated materials. Therefore, these materials have low levels of radioactivity. Emanation fraction test results for materials of low radioactivity are often inaccurate. Often results are reported as negative numbers. In these cases it is sometimes assumed that the emanation fraction is zero. Because of the low levels of radioactivity of these two samples, low emanation should be expected, and the low values based on the laboratory results are not surprising.

Implementation: None.

ATTACHMENT NO. 1

test methods and frequencies established by MK Ferguson for performing these tests. The (RAIP) was submitted for DOE approval and NRC concurrence prior to its implementation. All personnel who performed the tests were qualified and certified in accordance with the requirements of the approved MK-Ferguson Quality Assurance Program Plan. Summarized test results, quantities and actual test frequencies have been provided in Appendix E.

D. Radiological Verification - Remedial Actions

Soil verification was conducted at the Mexican Hat and Monument Valley sites following remedial action to demonstrate compliance with EPA soil cleanup standards. Prior to performing soil verification, excavation control using correlated gamma survey instruments was performed to initially determine if in-situ soil concentrations were approaching EPA Ra-226 soil standards. There were two buildings left on the Mexican Hat site at the completion of remedial action, the former Halchita Medical Clinic and the shop building. There were no buildings at the Monument Valley site. The former medical clinic was originally considered for inclusion/exclusion under the UMTRA Vicinity Property program as Property No. MH-021. After initial surveys the property was excluded from the program because the building met all of the EPA standards. Therefore, no remediation was required on the former medical clinic. The shop building

required some decontamination to remove surface contamination and after decontamination the building met the surface contamination limits given in the RAP as well as the EPA Standards for WL and gamma measurements.

- Soil Verification Methods

Soil Verification samples were collected in accordance with approved health physics procedures (see Appendix J). Both sites were gridded in 30 foot by 30 foot grids in accordance with the individual site verification drawings. Control points were established by licensed surveyors and the grids were physically established on the ground by measuring from these points. Composite samples were collected within these grids by collecting nine, 0" to 6" test plugs of soil. These plugs were then homogenized in a container and an approximately 500 gram sample was collected for radiological measurement. All samples were identified by and traceable to, the respective grid from which they were collected.

In addition to the above method, two in-situ soil verification methods were also employed at the Mexican Hat and Monument Valley sites to perform gamma scanning, use of the RTRAK mobile gamma scanning tractor and the Hand-held Gamma Verification System (HGVS). The HGVS was used in areas where solid rock was exposed after excavation was completed. A solid rock verification protocol was developed by the RAC and Revision B of the proposed protocol was approved by the DOE for field use. A copy of this protocol is provided at the back of Appendix J along with a copy of the correlation data.

C. Geotechnical Testing:

Geotechnical tests performed were within the following three categories:

1. Testing for exploratory reasons: These were investigations for potential sources of borrow material to meet the specification requirements. This work was performed under the direction of an MKES Geotechnical Engineer and/or Geologist.

2. Testing for durability of erosion protection materials (riprap and bedding materials):

   - Sodium Sulfate Soundness
   - L.A. Abrasion
   - Specific Gravity and Absorption
   - Schmidt Rebound Hardness
   - Splitting Tensile Strength

These tests were performed by a commercial testing laboratory rather than on-site due to the expense of the testing equipment involved to perform these particular tests.

3. Field testing to verify that the work performed complies with the specified requirements: The Remedial Action Inspection Plan (RAIP) described the

test methods and frequencies established by MK-Ferguson for performing these tests. The (RAIP) was submitted for DOE approval and NRC concurrence prior to its implementation. All personnel who performed the tests were qualified and certified in accordance with the requirements of the approved MK-Ferguson Quality Assurance Program Plan. Summarized test results, quantities and actual test frequencies have been provided in Appendix E.

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In addition to the above method, two in-situ soil verification methods were also employed at the Mexican Hat and Monument Valley sites to perform gamma scanning, use of the RTRAK mobile gamma scanning tractor and the Hand-held Gamma Verification System (HGVS). The HGVS was used in areas where solid rock was exposed after excavation was completed. A solid rock verification protocol was developed by the RAC and Revision B of the proposed protocol was approved by the DOE for field use. A copy of this protocol is provided at the back of Appendix J along with a copy of the correlation data.

- Soil Measurement Methods

Radiological verification of remedial action was conducted through the use of on-site radium-226 (Ra-226) analysis of soil gamma-ray spectrometry systems employing two opposed 7.6 cm x 7.6 cm (3 in. x 3 in.). NaI(Tl) detectors were used to measure the 1765 keV gamma-rays from the Ra-226 daughter product Bismuth-214, and the 2615 keV gamma-rays from the Thorium-232 (Th-232) daughter product Thallium-208. All verification soil samples were counted initially in the wet unequilibrated state and then a site/area specific moisture/emanation correction factor was used to project an equilibrated value. This initial count allowed decisions affecting the construction schedule to be made. After the initial count, the samples were oven dried, then sealed and allowed to equilibrate. After a minimum of 20 days the samples were re-analyzed and final Ra-226 results recorded in the Site Verification Log and on the official site verification grid drawings. Leak testing was performed on two percent of the samples by immersion in hot water and observing for air bubbles which would indicate improper sealing.

The associated error of this system, designated as the Opposed Crystal System (OCS), was empirically determined to be less than ± 30% at a concentration of 5.0 pCi/g Ra-226 (95% confidence level). The minimum detectable activity was similarly determined to range from 1.1 to 1.3 pCi/g Ra-226, which is essentially the same value as background soil concentrations for the Mexican Hat (1.1 pCi/g) and Monument Valley (1.0 pCi/g) area.

RTRAK is a modified farm tractor which incorporates four 4" NaI(Tl) scintillation detectors to conduct mobile gamma surveys. The detectors are coupled to a multi-channel analyzer that is set up to measure the Bismuth-214 609 keV gamma-ray energy. The radiation measurement capabilities are supplemented by a microwave location system and a microcomputer for data analysis and presentation. These systems provide an average gamma count rate for each grid block (30 X 30 foot) in the survey area. Through careful calibration in areas with known soil concentration, the gamma count rate is converted to Ra-226 concentration in soil. The RTRAK soil verification system has been fully approved by the NRC and DOE.

The HGVS is based on a correlation of average gamma count measurements (from 9 locations) and composite soil Ra-226 concentrations obtained from 100 $m^2$ (30 foot x 30 foot) grids. During verification the HGVS required gamma count measurements at nine distributed locations in each verification grid. The nine measurements were then arithmetically averaged and the average used to determine compliance with EPA standards based on conclusions drawn from the correlation data. The methodology used for verification using the HGVS is presented in Appendix J.

- Soil Measurement Quality Control

The requirement for independent analysis of 4% of all verification samples was implemented at the Mexican Hat and Monument Valley sites. Barringer Laboratories provided laboratory analysis of all soil QA verification samples. A summary of this data is presented in Appendix J.

Calibration and routine performance checks utilizing National Institute of Standards and Technology (NIST) traceable reference material standards (5.12 pCi/g Ra-226) from the Technical Measurements Center in Grand Junction, Colorado were routinely conducted on the OCSs used at the Mexican Hat site. Results of this quality assurance program for the 5.12 pCi/g reference standard is also presented in Appendix J.

Daily performance checks were conducted on the RTRAK mobile gamma scanning tractor and instruments used to perform HGVS measurements prior to each days use. These routine checks ensured that the instruments were operating within the prescribed limits contained within the operating procedures. Quality control samples were also collected and analyzed in the laboratory to provide additional quality assurance of the in-situ verification measurement systems. A summary of the quality control measurement results are presented in Appendix J.

The soil verification results presented in Appendix J were independently checked by the health physics technical staff, to ensure accuracy. This completed the final step in the quality assurance program for radiological testing.

- Grid Establishment, Survey, and Soil Sampling

A description of gridding, surveying and soil sampling requirements is included in the verification procedures presented in the back of Appendix J.

- Soil Verification Results

The Remedial Action Plan required verification of cleanup for Ra-226, Ra-228, Th-232 and Th-230. Verification information for these radionuclides are contained in Appendix J. The drawings presented in Appendix J show all verification grid locations for the Mexican Hat and Monument Valley sites. Each grid is identified by soil sample location. Ra-226 and Th-232 concentrations determined by OCS measurements and independent quality control analytical results for Ra-226, Th-232, and Th-230 are presented in accompanying tables for each drawing, by sample number. Also accompanying each drawing are RTRAK and HGVS measurement results. The summary and results presented in Appendix J clearly demonstrate that all Mexican Hat and Monument Valley verification samples met the EPA standards.

- Radiological Analysis of Backfill

Uncontaminated material was utilized on the Mexican Hat and Monument Valley sites for backfill. This material was routinely analyzed on the site OCS system to ensure the material was suitable for backfill. A summary of the backfill analytical data is presented in Appendix J.

- Radon Flux Measurements

Radon flux measurements were performed at 105 evenly spaced locations on the Mexican Hat disposal cell. These measurements were performed after all radon barrier material had been placed and prior to long term stabilization by placement

of bedding and riprap erosion protection cover materials. All radon flux measurements were performed in accordance with approved RAC procedures (OP-003-5, Radon Flux Measurements). The average measured radon flux was 0.05 $pCi/m^2$-s, which is well below the standard of 20 $pCi/m^2$-s allowed by National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations, 40 CFR 61, Subpart T. Radon flux measurement data is presented in Appendix J.

ATTACHMENT NO. 2

This area is characterized by a rock surface covered by 4 to 18 feet of "shot rock" blasting debris. Since the area was backfilled with more than six inches of material, the 15 pCi/g EPA standard applies. Data supporting the decision to leave the 13 grids unsampled along with a letter of concurrence from NRC is presented following the tables in this appendix.

Grid number T-28-13 was wholly under the paved road therefore it was not sampled. Samples taken from surrounding locations indicate that the general area meets the Ra-226 limits given in the EPA Standards. The location of the road on Drawing Sheet T is an approximation and therefore does not accurately represent the location of grid number T-28-13 in relation to the road. Verification in Area J was performed up to the edge of the sewage ponds in Blocks 31, 38 and 39. Due to the biological hazards associated with sampling in sewage ponds, no further standard verification sampling was conducted in these areas. However, several samples were taken from the excavation face which indicated that the contamination had been removed prior to placement of backfill. (Backfill was placed to a depth greater than 15cm.) The maximum Ra-226 concentration for the samples collected was 7.4 pCi/g.

Large sections of Areas F, G, L, M, Q and R are un-verified. These sections are located under the Mexican Hat disposal cell. The west section of Area T, (Blocks 19, 27 and 35) inside the contamination limits line, was verified under the UMTRA Vicinity Property Program. Grid 0-31-01 was located completely under the sheet metal shop foundation.

Some contamination in Verification Areas C, CC, E and EE associated with the drainages to the north and northeast of the pile fell outside of the contamination boundary indicated on the verification drawings. The verification data for these areas are included in Table J.5.

Four Barringer Laboratory Ra-226 soil verification sample analysis results exceeded the EPA standard of 5 pCi/g plus background. These samples are HAT-SV-F-47-4, HAT-SV-C-35-24, HAT-SV-N-30-14 and HAT-SV-N-15-3 (with Barringer Ra-226 Concentrations of 6.4 ± 1.3, 7.1 ± 1.3, 6.8 ± 1.3, and 6.2 ± 1.2, respectively). The OCS initial corrected and 20-day Ra-226 concentrations for each of these samples were both below the EPA Standards. In addition, the two sigma errors associated with the Barringer analytical results place the values within the EPA Standards, indicating that as Ra-226 concentrations fall close to the standard, occasionally a Barringer result will exceed the standards. Based on this information and reasons given in section 1 of this appendix, the on-site laboratory OCS results were used to verify compliance with EPA Standards.

One Barringer Laboratory Th-232 sample analysis result exceeded the limits given in the RAP by 0.9 pCi/g (HAT-SV-P-46-05, 6.9 ± 1.4 pCi/g). The sample was counted on the site OCS system and the result was 2.5 pCi/g. The two sigma error limits range on the Barringer Th-232 analytical result encompassed the RAP limit. Based on this information and reasons given in section 1 of this appendix, the site laboratory result was used to determine compliance with the RAP Th-232 cleanup criteria. ~~In addition, prior to the sampling of this grid location, the DOE provided direction to the RAC by letter to use a cleanup limit of 10 pCi/g as outlined in the Nuclear Regulatory Commissions's guidance document entitled "Guidelines for Concentrations of Thorium and Uranium Wastes in Soil." A copy of this letter is presented following the tables in this appendix.~~

One Barringer HGVS quality control sample result exceeded the EPA standards by 0.7 pCi/g (HAT-HG-H-01-25, 6.8 ± 1.4 pCi/g). The two sigma error limits for the Barringer analytical result encompasses the EPA Standards. Based on this information and the reasons given in section 1 of

Mexican Hat. There were over 300 quality control samples collected to verify the validity of the RTRAK data. The average RTRAK Ra-226 soil concentration was 2.5 pCi/g as compared to the average OCS Ra-226 soil concentration for the same samples of 2.1 pCi/g.

Of the grids verified using the HGVS, 5% were verified by collecting quality control verification soil samples at the nine measurement locations, forming a composite, analyzing the sample and using the information to check the overall quality of the HGVS measurements. HGVS QC samples were analyzed on the site laboratory OCS system, or at Barringer Laboratories. For the 159 (5.7%) quality control samples collected, the average laboratory result was 1.5 pCi/g and the average HGVS result was 1.9 pCi/g. ~~Since the HGVS quality control verification samples were taken according to the criteria established in verification procedures, the results from site OCS measurements are reported in the OCS soil verification tables and in the HGVS verification table lab results.~~

197 (20%) of the 976 samples counted on the Mexican Hat OCS soil counting systems for Th-232 were sent out to Barringer Laboratories for independent analysis. The Average OCS Th-232 concentration was 0.8 pCi/g as compared to the Barringer average of 0.9 pCi/g.

All radon flux measurements were performed in accordance with RAC Health Physics Procedure RAC-025, Radon Flux Measurements. Radon flux measurement duplicates (10%) were counted which documented the reproducibility of the counting technique. The results are presented in Table J.3. All radon flux measurements were reviewed by qualified health physics personnel. A copy of the procedure used to conduct radon flux measurements at the Mexican Hat site is presented following the table in this appendix.

indicated Ra-226 concentrations at or near instrument detection levels. Measurements conducted around the outside of the building indicated the presence of tailings on the surrounding grounds.

During the project the soil surrounding the building was remediated and verification samples were collected to verify cleanup to EPA standards. During remedial action the building was used for storage. Near the completion of the project gamma, Working Level (WL) and contamination measurements were conducted in the building prior to final release. Gamma measurements indicated contact gamma levels were elevated (50 $\mu$R/hr) above background against the brick and cinder block walls in the building. Samples of the building materials were ~~are being~~ collected and analyzed at the Slick Rock on-site laboratory. The samples results indicated that the mortar used in the construction of the walls had elevated Ra-226 concentrations. Additional dose rate surveys were conducted at 1 foot in the shop building rooms to determine the minimum, maximum and most common dose rates. Although there were some elevated contact gamma readings, the maximum and most common dose rates at 1 foot were below 20 $\mu$rem/hr (excluding background of 10 $\mu$rem/hr).

Radon progeny measurements were below 0.02 WLs. Contamination levels were elevated in some areas of the building, but after decontamination the same areas met the prescribed limits outlined in the remedial action plan. Non-removable contamination measurements ~~limits~~ were conducted with a beta-gamma instrument. The RAC has established a beta-gamma to alpha ratio of 0.7 to 1.0, respectively, for use when surveying for tailings contamination. Area E of the building had non-removable contamination that exceeded the specified total contamination limits. The values given in the RAP were obtained from NRC regulatory guide 1.86, which allows individual measurements to be as high as three times the limit, as long as

the concentration levels averaged over one square meter do not exceed the limit. Area E was resurveyed and the average non-removable contamination level, along with removable contamination, was well within the limit for total contamination. Verification data indicating compliance with cleanup criteria for the sheet metal shop are presented following the tables in this appendix. ~~Once the results from the building materials samples are available and this issue is resolved, an addendum to the completion report will be issued containing the final gamma survey results.~~

# APPENDIX J
# VERIFICATION MEASUREMENTS

This appendix contains radiological soil verification data and supporting quality control data indicating that soil verification measurements following remedial action at the Mexican Hat and Monument Valley sites have met the radium-226 (Ra-226) Standards established by the EPA in Title 40 of the Code of Federal Regulations, Part 192. Appendix J contains soil verification data indicating thorium-230 (Th-230) levels which, after 1,000 years of decay and radium ingrowth, will not exceed the Ra-226 standards. In addition, this appendix contains information indicating Th-232 and Ra-228 have been remediated to the criteria established in the Remedial Action Plan (RAP).

## A. Soil Verification

### 1. Radiological Verification Measurement Methods

Approved procedures for soil verification measurements on the UMTRA Project were used on the Mexican Hat and Monument Valley sites and a copy of the procedures are included in the back of this appendix. These procedures explain the method for soil verification sample collection. Verification measurements using both sampling and in-situ techniques were employed at the Mexican Hat and Monument Valley sites. Two types of in-situ measurements were performed, RTRAK gamma survey measurements using a gamma scanning tractor and Hand-held Gamma Verification System (HGVS) measurements.

The RAP stated that Ra-228 was to be remediated. No direct measurements were made for Ra-228, but surrogate measurements of Th-232 were routinely conducted at the Mexican Hat site. Since Ra-228 is the direct radioactive decay product of Th-232 and the half-life of Ra-228 is relatively short (6.7 years) as compared to Th-232 ($1.4 \times 10^{10}$ years) they were assumed to be

in radioactive equilibrium. It is assumed that by cleaning up Th-232 to the appropriate criteria, Ra-228 would also be remediated to satisfy the criteria. The characterization data from the Monument Valley site indicated that there were no elevated levels of Th-232 at the site. The highest concentration of Th-232 was approximately 17 pCi/g, located in the highest levels of tailings. For the above stated reasons, Th-232 measurements were not conducted at the Monument Valley site.

Performance criteria for radiological soil sample analysis of ± 30% error limits at the 95% confidence level was achieved with the Opposed Crystal soil analysis System (OCS) utilized at the Mexican Hat site. Monument Valley soil verification samples were analyzed at the Mexican Hat site laboratory. The error limits were empirically determined, utilizing National Institute of Standards and Technology (NIST) traceable reference material counts (5.12 pCi/g Ra-226) collected routinely during the verification process. Reference material was supplied to the RAC by the Technical Measurements Center in Grand Junction, Colorado. Preparation and analyses information can be found in report #GJ/TMC-10-83 UC-70A. The background Ra-226 concentration for the Mexican Hat area is 1.1 pCi/g and for the Monument Valley area is 1.0 pCi/g. The background Th-232 concentration for the Mexican Hat site was 1.0 pCi/g. Four OCSs were utilized at the site for verification soil analysis. The instrument standard quality control check data for all four instruments are presented in Tables J.1 and J.2. OCS #4 was not used for Th-232 analysis. All of the quality control check data indicates that the performance criteria outlined above has been satisfied. Minimum detectable concentrations for Ra-226 on all of the OCSs was approximately equal to background, ranging from 1.1 to 1.3 pCi/g. Minimum detectable concentrations for Th-232 on the site OCSs was approximately 1.5 pCi/g.

Since Th-230 is the radioactive parent of Ra-226, elevated levels of Ra-226 can develop over long periods of time (hundreds of years) when Th-230 is

present in elevated concentrations. Excavation control was conducted at the Mexican Hat and Monument Valley sites such that the EPA limits would not be exceeded due the ingrowth of Ra-226 from present levels of Th-230 and the decay of Ra-226 in 1,000 years. This was accomplished by calculating a projected 1,000 year Ra-226 concentration from present levels of Ra-226 and Th-230. Verification measurements for Th-230 were conducted on more than 6% of the grids at the Mexican Hat site and nearly 5% of the grids at the Monument Valley site. Additional measurements were conducted for areas suspected of having elevated concentrations of Th-230 in underlying soil such as heap leach areas, raffinate ponds and the upper tailings pile. If sampling indicated Th-230 in excess of the guideline, the surrounding grids were also sampled and analyzed for Th-230. Analysis for Th-230 was conducted by an independent vendor laboratory from the Remedial Action Contractor's (RACs) approved vendors list.

For areas of low level contamination such as areas contaminated by windblown tailings, an alternative verification technique was used. Verification in these areas was performed using a comprehensive gamma survey with the RTRAK mobile scanning vehicle. RTRAK is a modified farm tractor which incorporates four NaI(Tl) scintillation detectors to conduct mobile gamma surveys. The radiation measurement capabilities are supplemented by a microwave location system and a microcomputer for data analysis and presentation. These systems provide an average gamma count rate for each grid block (30 X 30 foot) in the survey area. Through careful calibration in areas with known soil concentration, the gamma count rate was converted to Ra-226 concentration in soil. The RTRAK soil verification system has been fully approved by the NRC and DOE. A copy of the approved procedures for calibration and operation of the RTRAK system are included at the back of this appendix.

Based on site-specific concerns, namely verification of solid rock, the HGVS was used to verify some areas of the Mexican Hat and Monument Valley sites to demonstrate reasonable assurance that mill tailings had been cleaned up

to EPA standards. The HGVS is based on a correlation of average gamma count measurements (from 9 locations) and composite soil Ra-226 concentrations obtained from 100 $m^2$ grids. During verification the HGVS required gamma count measurements at nine distributed locations in each verification grid. The nine measurements were then arithmetically averaged and the average used to determine compliance with EPA standards. A solid rock verification protocol was developed by the RAC and Revision B of the proposed protocol was approved by the DOE for use in the field. The application of this protocol was modified as discussed in the following text. The modifications imposed provided more conservative Ra-226 concentration estimations. A copy of this protocol is provided at the back of this appendix.

Thirty pairs of gamma count rate and Ra-226 concentration measurements made using the OCS were collected at the site in accordance with Sections 3.1 (a,b,c) of the protocol.

This data set was used to estimate the correlation between gamma and Ra-226, the line of best fit between the Ra-226 and gamma count rate data, and the curve representing the 95% lower prediction limit for the gamma count rate associated with any given OCS Ra-226 measurement.

Verification gamma measurements were converted to Ra-226 concentration values using a linear approximation of the lower 95% prediction curve. A grid was determined to meet EPA standards for Ra-226 if this predicted value was less than 5 pCi/g. The procedure followed at the Mexican Hat and Monument Valley sites set a higher (more conservative) standard for cleanup than would have occurred following Section 3.1 (e,f) of the protocol. With the implemented procedure, the maximum allowed count rate to meet the EPA standards is 3267 counts per half minute, which is more conservative than

using the maximum allowed count rate from the written protocol of 4276 counts per half minute.

All verification results reported in Appendix J include soil background. Occasionally negative values are reported for a location within the verification data tables. These values occur as a natural variation of radiological measurements and indicate that the measurement at that location was less than instrument background.

Due to the natural error associated with radiological measurements, occasionally an independent laboratory result exceeded the EPA or RAP limits while the site verification measurement met the limits. The purpose of the independent laboratory analysis is not to provide a quality control check on each sample analyzed, but to provide quality assurance for the overall site verification program. The majority of the time, the area excavated has been backfilled based on the site laboratory result before independent laboratory results are received at the site. To minimize the impact on operations costs and schedules, backfilling generally must be completed in a timely manner. For the above stated reasons, the Remedial Action Contractor utilized the site OCS, RTRAK or HGVS measurement to determine compliance with the standards. In the event a 20-day (equilibrated) OCS measurement exceeded the limits, the subcontractor returned to the location to perform additional excavation and the area was then resampled.

2. Radiological Verification Results

a. Mexican Hat Verification Results

The average Ra-226 concentration including background for 7,338 Mexican Hat site verification samples, was 2.1 pCi/g with a maximum concentration of 15.5 pCi/g. Of the 464 verification samples analyzed by Barringer

Laboratories for Th-230, the average concentration was 2.9 pCi/g and the maximum was 26 pCi/g. Table J.5 includes the individual verification results for each grid location sampled along with an area drawing at the front of the data for each of the 27 areas. Table J.5 also includes the estimated 1,000 year Ra-226 result for all samples with site Ra-226 and Barringer Laboratory Th-230 results. In addition to the above information, Table J.5 contains Th-232 analysis, RTRAK verification, and HGVS verification results for the Mexican Hat site. The average concentration of the 976 samples analyzed at the Mexican Hat site for Th-232 was 0.8 pCi/g and the maximum concentration was 5.0 pCi/g. The average Ra-226 concentration for over 4,100 RTRAK verification grid locations was 2.6 pCi/g and the maximum concentration was 9 pCi/g. The average Ra-226 concentration for over 500 HGVS measurements taken at the Mexican Hat site was 2.7 pCi/g and the maximum concentration was 4.1 pCi/g.

In 1989, a large area of the Mexican Hat site was verified using the RTRAK system. Some parts of Area N were inadvertently missed or had insufficient data to maintain 95% confidence levels during the verification process. After the RTRAK data was processed these areas were identified and a soil verification crew went out and obtained samples to fill in the missing data. Later, debris from the blasting operation at the site was used to fill a gully in Area N. It was discovered afterwards that one strip was inadvertently overlooked, leaving 13 grid locations with limited or no verification data. This area is characterized by a rock surface covered by 4 to 18 feet of "shot rock" blasting debris. Since the area was backfilled with more than six inches of material, the 15 pCi/g EPA standard applies. Data supporting the decision to leave the 13 grids unsampled along with a letter of concurrence from NRC is presented following the tables in this appendix.

Grid number T-28-13 was wholly under the paved road therefore it was not sampled. Samples taken from surrounding locations indicate that the general

area meets the Ra-226 limits given in the EPA Standards. The location of the road on Drawing Sheet T is an approximation and therefore does not accurately represent the location of grid number T-28-13 in relation to the road. Verification in Area J was performed up to the edge of the sewage ponds in Blocks 31, 38 and 39. Due to the biological hazards associated with sampling in sewage ponds, no further standard verification sampling was conducted in these areas. However, several samples were taken from the excavation face which indicated that the contamination had been removed prior to placement of backfill. (Backfill was placed to a depth greater than 15cm.) The maximum Ra-226 concentration for the samples collected was 7.4 pCi/g.

Large sections of Areas F, G, L, M, Q and R are un-verified. These sections are located under the Mexican Hat disposal cell. The west section of Area T, (Blocks 19, 27 and 35) inside the contamination limits line, was verified under the UMTRA Vicinity Property Program. Grid 0-31-01 was located completely under the sheet metal shop foundation.

Some contamination in Verification Areas C, CC, E and EE associated with the drainages to the north and northeast of the pile fell outside of the contamination boundary indicated on the verification drawings. The verification data for these areas are included in Table J.5.

Four Barringer Laboratory Ra-226 soil verification sample analysis results exceeded the EPA standard of 5 pCi/g plus background. These samples are HAT-SV-F-47-4, HAT-SV-C-35-24, HAT-SV-N-30-14 and HAT-SV-N-15-3 (with Barringer Ra-226 Concentrations of 6.4 ± 1.3, 7.1 ± 1.3, 6.8 ± 1.3, and 6.2 ± 1.2, respectively). The OCS initial corrected and 20-day Ra-226 concentrations for each of these samples were both below the EPA Standards. In addition, the two sigma errors associated with the Barringer analytical results place the values within the EPA Standards, indicating that

as Ra-226 concentrations fall close to the standard, occasionally a Barringer result will exceed the standards. Based on this information and reasons given in section 1 of this appendix, the on-site laboratory OCS results were used to verify compliance with EPA Standards.

One Barringer Laboratory Th-232 sample analysis result exceeded the limits given in the RAP by 0.9 pCi/g (HAT-SV-P-46-05, 6.9 ± 1.4 pCi/g). The sample was counted on the site OCS system and the result was 2.5 pCi/g. The two sigma error limits range on the Barringer Th-232 analytical result encompassed the RAP limit. Based on this information and reasons given in section 1 of this appendix, the site laboratory result was used to determine compliance with the RAP Th-232 cleanup criteria.

One Barringer HGVS quality control sample result exceeded the EPA standards by 0.7 pCi/g (HAT-HG-H-01-25, 6.8 ± 1.4 pCi/g). The two sigma error limits for the Barringer analytical result encompasses the EPA Standards. Based on this information and the reasons given in section 1 of this appendix, the site result (2.1 pCi/g) was used for determining compliance with the standards.

b. Monument Valley Verification Results

The average Ra-226 concentration including background for 4,502 Monument Valley site verification samples was 1.4 pCi/g with a maximum concentration of 6.3 pCi/g. Of the 221 verification samples analyzed by Barringer Laboratories for Th-230, the average concentration was 1.9 pCi/g and the maximum was 29 pCi/g. Table J.6 includes the individual verification results for each grid location sampled along with an area drawing at the front of the data for each of the 14 areas. Table J.6 also includes the estimated 1,000 year Ra-226 result for all samples with site Ra-226 and Barringer Laboratory Th-230 results. In addition to the above information Table J.6 contains HGVS

verification results for the Monument Valley site. The average Ra-226 concentration for over 2,200 HGVS measurements conducted at the Monument Valley site was 1.8 pCi/g and the maximum concentration was 5.7 pCi/g.

According to the contamination limits set forth in the RAP, no excavation or verification was conducted in Areas F, G, K, and L. The contamination limits have been re-drawn on Sheets H and M to match those prescribed in the Remedial Action Plan. The redrawn limits on Sheet H and M indicate the boundary between UMTRA process site related materials and abandoned mine land related materials. The drawings (Sheets H and M) have been updated since they were originally prepared prior to the separation of the UMTRA and abandoned mine land materials.

One Barringer Laboratory Ra-226 sample analysis result exceeded the EPA standard by 0.2 pCi/g (Sample # MON-SV-J-27-25, 6.2 ± 1.3 pCi/g). The two sigma error limits for the Barringer analytical result encompasses the EPA Standards. The site laboratory initial corrected count, and the 20-day count (2.9 and 3.9 pCi/g, respectively) were very similar in activity and well within the EPA standards for Ra-226. Based on this information and the reasons given in section 1 of this appendix, the site results were used to compare to the EPA Standards.

3. Quality Control of Radiological Measurements

The quality control program for radiological measurements complies with the criteria set forth in the UMTRA Project Quality Assurance Plan, the RAC Quality Assurance Procedures Plan, and DOE Order 5700.6C. The quality control program for Ra-226 and Th-230 radiological measurements required 4% of all verification samples to be reanalyzed at an off-site independent laboratory. This service was performed by Barringer Laboratories.

Barringer laboratories is certified by the U.S. Environmental Protection Agency, Region VIII to perform Ra-226 radiochemical analyses. Each analytical report received from Barringer Laboratories is accompanied by a quality control data sheet which specifies lower limits of detection. Also included are duplicate sample results (10%) and results for quality control standards (5%) including Barringer result, certified result, acceptable target range and relative deviation from the known value (acceptable deviations ± 5%). All original Barringer reports for soil analyses are available in DOE archived records. Barringer quality control samples were analyzed for approximately 5.4% (645) of the verification samples. The average Barringer quality control sample Ra-226 concentration was 2.3 pCi/g as compared to the site average for the quality control samples of 2.3 pCi/g.

Verification performed by the RTRAK after remedial action maintained an error limit of less than 30% at the 95% confidence level. The RTRAK was calibrated with quality control samples analyzed on the OCS system at Mexican Hat. There were over 300 quality control samples collected to verify the validity of the RTRAK data. The average RTRAK Ra-226 soil concentration was 2.5 pCi/g as compared to the average OCS Ra-226 soil concentration for the same samples of 2.1 pCi/g.

Of the grids verified using the HGVS, 5% were verified by collecting quality control verification soil samples at the nine measurement locations, forming a composite, analyzing the sample and using the information to check the overall quality of the HGVS measurements. HGVS QC samples were analyzed on the site laboratory OCS system, or at Barringer Laboratories. For the 159 (5.7%) quality control samples collected, the average laboratory result was 1.5 pCi/g and the average HGVS result was 1.9 pCi/g.

197 (20%) of the 976 samples counted on the Mexican Hat OCS soil counting systems for Th-232 were sent out to Barringer Laboratories for

independent analysis. The Average OCS Th-232 concentration was 0.8 pCi/g as compared to the Barringer average of 0.9 pCi/g.

All radon flux measurements were performed in accordance with RAC Health Physics Procedure RAC-025, Radon Flux Measurements. Radon flux measurement duplicates (10%) were counted which documented the reproducibility of the counting technique. The results are presented in Table J.3. All radon flux measurements were reviewed by qualified health physics personnel. A copy of the procedure used to conduct radon flux measurements at the Mexican Hat site is presented following the table in this appendix.

4. Backfill Material

Samples of backfill material were collected and analyzed on the OCS to determine the levels of Ra-226. The backfill sample data is on file at the UMTRA Project Office. The average Ra-226 concentration for 236 backfill samples taken at the Mexican Hat and Monument Valley site was 0.6 pCi/g and the maximum concentration was 4.6 pCi/g.

5. Radon Flux Measurements

Radon flux measurements are not to exceed 20 $pCi/m^2$-s as required by Title 40 of the Code of Federal Regulations, Part 61, Subpart T, also known as the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. Individual radon flux measurements ranged from -0.08 to 0.23 $pCi/m^2$-s. Figure J.1 shows the approximate location of the 105 flux measurement points on the 264,662 $m^2$ disposal cell. The radon flux measurements for Mexican Hat are presented in Table J.4 and clearly indicate compliance with NESHAP requirements.

6. Building Verification Information

As outlined in the remedial action plan, the sheet metal shop was to be remediated and surveyed to meet the appropriate criteria. Early in the project initial gamma measurements in the building indicated elevated gamma levels possibly caused by contamination surrounding the building or tailings material under the foundation. Boreholes were drilled through the concrete floor in six locations with a hammer-drill. Gamma measurements were conducted in the boreholes. Soil samples were taken at six inch intervals in the underlying soil to the bottom of the boreholes. No gamma anomalies were indicated and soil sample results from the on-site OCS indicated Ra-226 concentrations at or near instrument detection levels. Measurements conducted around the outside of the building indicated the presence of tailings on the surrounding grounds.

During the project the soil surrounding the building was remediated and verification samples were collected to verify cleanup to EPA standards. During remedial action the building was used for storage. Near the completion of the project gamma, Working Level (WL) and contamination measurements were conducted in the building prior to final release. Gamma measurements indicated contact gamma levels were elevated (50 $\mu$R/hr) above background against the brick and cinder block walls in the building. Samples of the building materials were collected and analyzed at the Slick Rock on-site laboratory. The samples results indicated that the mortar used in the construction of the walls had elevated Ra-226 concentrations. Additional dose rate surveys were conducted at 1 foot in the shop building rooms to determine the minimum, maximum and most common dose rates. Although there were some elevated contact gamma readings, the maximum and most common dose rates at 1 foot were below 20 $\mu$rem/hr (excluding background of 10 $\mu$rem/hr).

Radon progeny measurements were below 0.02 WLs. Contamination levels were elevated in some areas of the building, but after decontamination the same areas met the prescribed limits outlined in the remedial action plan. Non-removable contamination measurements were conducted with a beta-gamma instrument. The RAC has established a beta-gamma to alpha ratio of 0.7 to 1.0, respectively, for use when surveying for tailings contamination. Area E of the building had non-removable contamination that exceeded the specified total contamination limits. The values given in the RAP were obtained from NRC regulatory guide 1.86, which allows individual measurements to be as high as three times the limit, as long as the concentration levels averaged over one square meter do not exceed the limit. Area E was resurveyed and the average non-removable contamination level, along with removable contamination, was well within the limit for total contamination. Verification data indicating compliance with cleanup criteria for the sheet metal shop are presented following the tables in this appendix.

ATTACHMENT NO. 3

# INTERIOR SURVEY EXPOSURE DATA LOG

SURVEY CREW R.E. Moore
D. Sickels

SHEET 1 OF 7 PAGE 1

DATE 2-1-96

PROPERTY ID # Mexican Hat Sheet Metal Shop

PROJECT UMTRA

## SURVEY INSTRUMENTS

GAMMA SCAN (2220/4410) INST. ID#s 31984 154967 CALIBRATION DATE 5-9-96

DOSE RATE (BICRON MICROREM) INST. ID# B 845 M CALIBRATION DATE 10-17-96

| ROOM | ~~GAMMA SCAN ANOMALIES~~ LOCATION | COMMENTS | DOSE RATE SURVEY MIN | MAX | MOST | LOC >20 µrem/h | COMMENTS |
|---|---|---|---|---|---|---|---|
| 1-1 | | | 8 | 10 | 10 | -NA- | $\bar{x}$ BKG = 10 µR/hr |
| 1-2 | | | 8 | 10 | 10 | -NA- | |
| 1-3 | | | 8 | 10 | 10 | -NA- | |
| 1-4 | | | 8 | 10 | 10 | -NA- | |
| 1-5 | | | 10 | 12 | 12 | -NA- | |
| 1-6 | | | 8 | 10 | 10 | -NA- | |

GENERAL COMMENTS: BKG = 10 µR/hr @ 1 ft

REVIEWED BY: [signature]

# INTERIOR SURVEY EXPOSURE DATA LOG

SURVEY CREW RE Moore
D. Sickels

SHEET 2 OF 7 PAGE 2

DATE 2-1-96

PROPERTY ID # Mex Hot sheet Metal Shop

PROJECT UMTRA

## SURVEY INSTRUMENTS

GAMMA SCAN (2220/4410) INST. ID#s 31984 154967 CALIBRATION DATE 5-2-96

DOSE RATE (BICRON MICROREM) INST. ID# B8454 CALIBRATION DATE 10-17-96

| ROOM | ~~GAMMA SCAN ANOMALIES~~ LOCATION | COMMENTS | DOSE RATE SURVEY MIN | MAX | MOST | LOC >20 µrem/h | COMMENTS |
|---|---|---|---|---|---|---|---|
| 1-7 | | | 8 | 12 | 10 | -NA- | $\bar{x}$ BKg = 10 µR/hr |
| 1-8 | | | 8 | 12 | 10 | -NA- | |
| 1-9 | N/A | | 8 | 12 | 10 | -NA- | |
| 1-10 | | | 8 | 12 | 10 | -NA- | |
| 1-11 | | | 8 | 12 | 10 | -NA- | |
| 1-12 | | | 8 | 12 | 10 | -NA- | |

GENERAL COMMENTS:

REVIEWED BY: [signature]

# INTERIOR SURVEY EXPOSURE DATA LOG

SURVEY CREW RE Moore
D. Sickels

SHEET 3 OF 7 PAGE 3

DATE 2-1-96

PROPERTY ID # Mex Hat Sheet Metal Shop

PROJECT JMTRA

SURVEY INSTRUMENTS

GAMMA SCA. 2220/4410) INST. ID#s 31984 154967 CALIBRATION DATE 5-9-96

DOSE RATE (MICRON MICROREM) INST. ID# 8845M CALIBRATION DATE 10-17-96

| ROOM | ~~GAMMA SCAN ANOMALIES~~ LOCATION | COMMENTS | DOSE RATE SURVEY MIN | MAX | MOST | LOC >20 µrem/h | COMMENTS |
|---|---|---|---|---|---|---|---|
| 1-13 | | | 8 | 12 | 10 | -NA- | $\bar{X}$ BHg = 10 µR/hr |
| 1-14 | | | 8 | 12 | 10 | -NA- | |
| 1-15 | | N/A | 8 | 12 | 10 | -NA- | |
| 1-16 | | | 8 | 12 | 10 | -NA- | |
| 1-17 | | | 10 | 12 | ~~40~~ 13 | -NA- | |
| 1-18 | | | 10 | 12 | ~~40~~ 13 | -NA- | |

GENERAL COMMENTS:

REVIEWED BY:

# INTERIOR SURVEY EXPOSURE DATA LOG

SURVEY CREW R E Moore
D Sickels

SHEET 4 OF 7 PAGE 4

DATE 2-1-96

PROPERTY ID # Hex Hut Sheet Metal Shop

PROJECT JMTRA

## SURVEY INSTRUMENTS

GAMMA SCAN (2220/4410) INST. ID#s 31984 154967 CALIBRATION DATE 5-9-96

DOSE RATE (BICRON MICROREM) INST. ID# 8845N CALIBRATION DATE 10-17-96

| ROOM | ~~GAMMA SCAN ANOMALIES~~ LOCATION | COMMENTS | DOSE RATE SURVEY MIN | MAX | MOST | LOC >20 µrem/h | COMMENTS |
|---|---|---|---|---|---|---|---|
| 1-19 | | | 8 | 12 | 10 | -NA- | $\bar{x}$ BKg = 10µR/hr |
| 1-20 | | | 8 | 12 | 10 | -NA- | |
| 1-21 | | | 8 | 12 | 10 | -NA- | |
| 1-22 | | | 10 | 12 | 12 | -NA- | |
| | NA | | | | NA | | |

GENERAL COMMENTS:

REVIEWED BY: Phillip Mohn

# INTERIOR SURVEY EXPOSURE DATA LOG

SURVEY CREW RE Moore
D. Sickels

SHEET 5 OF 7 PAGE 5

DATE 2-1-96

PROPERTY ID # Hex. Hut Sheet Metal Shop

PROJECT JMTRA

## SURVEY INSTRUMENTS

GAMMA SCAN (2220/4410) INST. ID#s 3184 1 54967 CALIBRATION DATE 5-8-96

DOSE RATE (BICRON MICROREM) INST. ID# B845M CALIBRATION DATE 10-17-96

| ROOM | ~~GAMMA SCAN ANOMALIES~~ LOCATION | COMMENTS | DOSE RATE SURVEY MIN | MAX | MOST | LOC >20 µrem/h | COMMENTS |
|---|---|---|---|---|---|---|---|
| #2 | | | 15 | 25 | 25 | -NA- | $\bar{X}$ BKg = 10 µR/hr |
| #3 | | | 15 | 25 | 25 | -NA- | |
| | | | | | | | |
| | NA | | | | NA | | |
| | | | | | | | |
| | | | | | | | |

GENERAL COMMENTS:

REVIEWED BY: Phillip Mohr

ATTACHMENT 2

Indoor
~~OUTDOOR~~ GAMMA SCREENING
SURVEY DATA SHEET

LOGGING CREW: R.E. Moore
D. Seckels

SHEET 6 OF 7 PAGE 6

DATE: 2-1-96

PROPERTY ID: Mex Hot Sheet Metal Shop

INSTRUMENT ID NO: L-2220 # 31984 / 440 # 54967

BACKGROUND CALCULATION:

#1 1047 + #2 1243 + #3 1218 = 3508 ÷ 3 = 1169 CPTM

| AREA: RM # 1 | | AREA: RM # 1 | | AREA: RM # 2 | | AREA: RM # 3 | |
|---|---|---|---|---|---|---|---|
| POINT ID | READING CPTM | POINT ID | READING CPTM | POINT ID | READING CPTM | POINT ID | READING CPTM |
| 1 Floor | 1134 | 13 Floor | 1347 | Floor | 1446 | Floor | 2107 |
| 1 N. Wall | 929 | 13 S. Wall | 1232 | N Wall | 1441 | N. Wall | 1656 |
| 1 S. Wall | 923 | 14 Floor | 1119 | E Wall | 1625 | E Wall | 1661 |
| 2 Floor | 1089 | 15 Floor | 1048 | S Wall | 1640 | S Wall | 1708 |
| 2 W. Wall | 1096 | 16 Floor | 1029 | W Wall | 1673 | W Wall | 1658 |
| 3 Floor | 1402 | 16 N. Wall | 1090 | | | | |
| 3 W. Wall | 1008 | 17 Floor | 1918 | | | | |
| 4 Floor | 1344 | 17 N Wall | 1510 | | | | |
| 4 S. Wall | 1081 | 17 E Wall | 1765 | | | | |
| 4.5 Wall | 1064 | 18 Floor | 1537 | | | | |
| 5 Floor | 1479 | 18 E Wall | 1814 | | | | |
| 5 S. Wall | 1048 | 19 Floor | 1178 | | | | |
| 6 Floor | 1368 | 20 Floor | 1685 | | | | |
| 7 Floor | 1302 | 20 S Wall | 1253 | | | | |
| 8 Floor | 959 | 21 Floor | 1600 | | | | |
| 8 N Wall | 884 | 21 S Wall | 1254 | | | | |
| 9 Floor | 961 | 22 Floor | 1011 | | | | |
| 9 N Wall | 841 | 22 E Wall | 1050 | | | | |
| 10 Floor | 909 | 22 N Wall | 881 | | | | |
| 11 Floor | 1115 | | | | | | |
| 12 Floor | 1463 | | NA | | | | |
| 12 S Wall | 1244 | | | | | | |

REMARKS: All readings taken @ 2 ft from the floor and wall surfaces.
The ceiling is inaccessible.

REVIEWED BY: Phillip Mahoney

F2-VP-001-2

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

RUST FEDERAL SERVICES INC.

## PROPERTY SURVEY SKETCH

Sheet 7 of 7

Site Location Mexican Hat Sheet Metal Shop

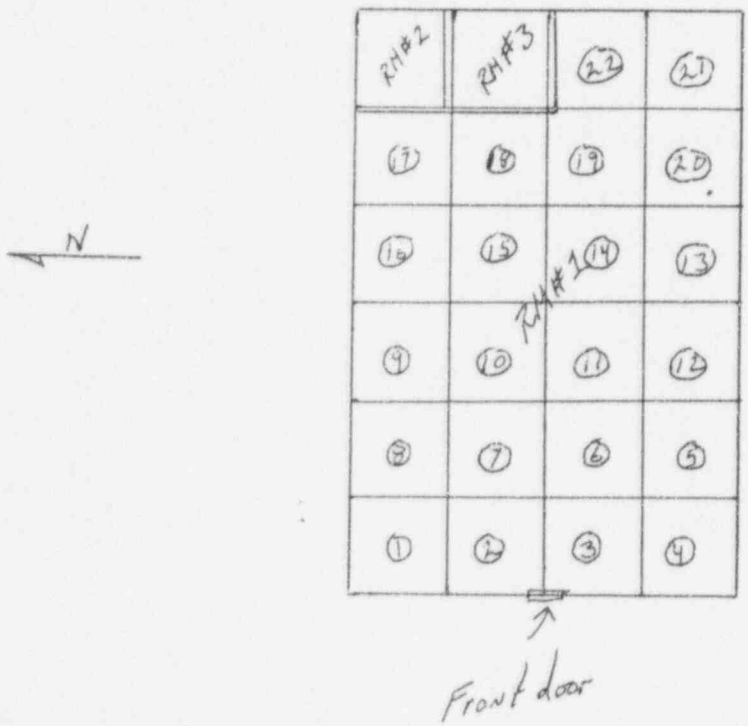
Address Mexican Hat S.Te.

Property Type Sheet Metal building LOT NO. NA

Owner Doe.

Sketch Completed by REMoore DATE 2-1-96

Interior grid system - Mexican Hat Sheet Metal Shop.




Interior Survey Grids 10'x10'

F1-VP-001-1

ATTACHMENT NO. 4

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 1

**REMEDIAL ACTION CONTRACTOR**
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

**APRIL 1997**

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 2
**Appendices A, B, C, and D**

**REMEDIAL ACTION CONTRACTOR**
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

**APRIL 1997**

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 3
### Appendix E

**REMEDIAL ACTION CONTRACTOR**
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

## APRIL 1997

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 3A
### Appendix E

REMEDIAL ACTION CONTRACTOR
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

## APRIL 1997

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 4
**Appendices F, G, H, and I**

**REMEDIAL ACTION CONTRACTOR**
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

**APRIL 1997**

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 5
### Appendix J

REMEDIAL ACTION CONTRACTOR
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

## APRIL 1997

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 6
**Appendix B**

**REMEDIAL ACTION CONTRACTOR**
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

## APRIL 1997

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATION OFFICE
CONTRACT NO. DE-AC04-83AL18796

# MEXICAN HAT, UT
# MONUMENT VALLEY, AZ

# FINAL
# COMPLETION REPORT

## VOLUME 6A
### Appendix B

**REMEDIAL ACTION CONTRACTOR**
FOR THE URANIUM MILL TAILINGS
REMEDIAL ACTION PROJECT

## APRIL 1997

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY